MODULE 11 GOOD WRITING IN SCIENCE

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3.1

STUDY GUIDE

The main aim of this Module is to help you develop better writing skills—its emphasis is on improving your written answers to questions in assignments that will be marked by a tutor. The Module is divided into four Sections. The first considers what is meant by good scientific writing. The second gives some practical help on how to write clearly. This is followed by a Section that shows how answers can be improved by the use of diagrams and equations, and the final Section concentrates on how to go about writing scientific accounts.

You cannot expect to acquire all of the skills of good scientific writing at this stage of your studies. Rather, this Module introduces you to good writing and how you can try to achieve it. The skill of writing, like many of the other skills you are developing, will improve with practice.

The scientific material used in this Module is based on earlier parts of *Into Science*. This will enable you to concentrate on the skills of writing rather than having to get to grips with new scientific ideas and terms. In addition, the activities in this Module, as well as improving your writing skills, also help you revise the concepts introduced in previous Modules. Working and interacting with the examples will show you how the process of revision is itself an active one.

There is a lot of work in this Module, particularly if you write your own answers to the questions set—which we strongly advise you to do. You should set aside six to eight hours to complete it, preferably in a number of study periods.

1 THE SKILL OF WRITING

The skill of writing clearly and effectively is important. It is useful in many work activities and in day to day activities, such as writing business letters. It also helps when you are writing assignments or answering examination questions. So it is worth spending time developing and improving this skill.

Of all the skills involved in studying and learning, that of writing is perhaps, the most daunting. Why should this be so? To answer this question consider a mathematics problem; in this case there is usually a single correct answer. By contrast, there are a large number of possible written answers and the outcome is less easily defined. Also *writing tests your understanding* of the subject; if this is incomplete it will be revealed in your writing. The challenge of writing is that it involves hard thinking which forces you to consider the material more actively and deeply; hence one of the rewards is *a better understanding of the subject.* Does this mean that you should not begin to write until your thinking on a topic is absolutely clear? The answer is 'no'. Even when your thinking is less than clear, the effort of having to put the ideas or argument down on paper makes you aware of the defects and weaknesses of your reasoning and thinking, and thus helps you to analyse your difficulty and gives you a chance to correct it. So the advantage of trying to write clearly and effectively is that *your reasoning along with your ability to think clearly will improve.*

Putting your ideas and thoughts on paper, that is expressing them to other people, means that they become part of your deep and active thought processes. So you will not be surprised to learn that the topics you write about are the ones that you learn and remember well. You will be reassured to learn that the questions in this Module are based on important topics. So spending time on the material will help you get to grips with some of the key concepts introduced in the Course.

1.1 FEATURES OF GOOD WRITING

The aim of this Section is to introduce you to the three essential elements of good scientific writing:

- clarity
- conciseness
- coherence

Let's look at each of these features of good scientific writing which are closely tied up with the purpose of writing.

□ What is the point or purpose of writing?

■ The purpose is to communicate with or transfer information to other people.

Consequently one essential feature of all good scientific writing is **clarity**. How can you judge whether a piece of writing is clearly written? The best way is to ask yourself; is it easy to understand? You may understand a topic perfectly, yet express your understanding poorly. Thus it is important that the meaning is clear. Let's look at an example.

Have you ever noticed that biscuit tins are not quite square? A puzzled customer, inquiring of a biscuit manufacturer why the tin containing his products were not square, was rewarded with the following letter:

> 'The existing sizes were developed because prior to the war, a much larger range of sizes were offered. Small tins were then available which were known as number 1 and number 2 sized tins, and for stacking purposes four number 1 sized tins equalled in size the half square biscuit tin. Eight number 1 tins were equal in size to a square tin. These very conveniently fitted both racks and storage spaces and we are afraid that any alteration of the size would now cause considerable inconvenience to the trade.'

□ Is the explanation easy to understand?

■ We are sure that you agree that the meaning is not clear!

Now look at the second feature of good writing, **conciseness.** Being concise means saying what you want to say in as few words as possible; it is the opposite of a rambling style which is often repetitious and therefore difficult to understand.

Suppose you ask two people, 'What is the time'?

□ *The first answers,* 'It is about 30 minutes before my coffee break which yesterday was about two hours before lunch, which was an hour after noon.'

The second answers, '10.30 am'.

Which answer is easier to understand?

■ We are sure you had no difficulty in answering this! The short direct answer is easier to understand.

The third feature of good writing is **coherence**. For a piece of writing to be coherent it must have a logical flow. Imagine that you are following a set of instructions to make a cake or build a car from Meccano or Lego. The instructions need to be given in the right order otherwise you end up either taking twice as long to make it or with the wrong end product!

□ Are the following instructions for making a cake in a logical order?

1 Mix the ingredients together in a bowl

2 Measure each of the ingredients.

3 Bake in a moderate oven.

4 Assemble eggs, butter, flour and sugar.

■ They clearly are not! You would assemble the ingredients, measure them, mix them and finally bake them.

So the order in which the material is presented is an important feature of good writing, whether it is a list of instructions, a range of descriptions or arguments. The three features of good writing, clarity, conciseness and coherence, are demonstrated in the following Sections. By the time you reach the end of these Sections you should have a better grasp of how to achieve good writing in science.

2 PLAIN WORDS IN SCIENCE

The aim of this Section is to help you write clearly, concisely and coherently. You learnt in Section 1 that good writing contains not only the correct information but is clearly expressed. How can you learn to be a good writer and express yourself clearly? The answer is, with practice! When you are writing, the meaning of what you want to say must be kept in mind. This Section begins with a few hints about the basic tools of writing: words and sentences.

2.1 WORDS

Simple words are easier to understand

□ Should you use a simple word or a complex long one? Try to answer this question for yourself by deciding which of the following alternatives you prefer to read and write:

(a) shown or manifested (b) find out or ascertain

(c) started or commenced (d) use or utilize ?

■ We think you will agree that in each case the simple words (the first in each example) are more direct; they are easier to use, to read and to understand.

Of course, under certain circumstances the long one may be more appropriate but in most instances the simple words are correct and easier to use.

□ Suggest simpler words which could be used to replace the following:

(a) prior to the commencement of (b) after the cessation of

■ (a) before starting (b) after stopping

But what about using technical terms of which there are a great many in science? Technical terms have a very precise meaning so it is important to use them correctly. There are two important aspects to consider here. One is related to the use of technical terms that have become part of every day language and are used less precisely. The second is whether and how much you should use technical terms. Let's consider each of these aspects in turn.

There can be a problem when scientific terms are used incorrectly in every day language. For example, you will be aware of the terms 'melt' and 'dissolve' which have a precise scientific meaning. When a solid such as ice *melts* it changes into a liquid, water. A solid *dissolves* in a liquid. The correct meaning of 'melt' means a change of form (Modules 5/6) whereas 'dissolve' is an interaction between solid and liquid.

□ Which of the following sentences uses these words correctly?

(a) *Melt* the butter in the saucepan at low heat.

(b) Candy which *melts* in your mouth not in your hand.

(c) Stir to *dissolve* the instant coffee granules in the hot water.

(d) Add boiling water to the sugar until it *melts* to a thin syrup.

■ (a) is correct; butter melts on heating

(b) is wrong; the candy dissolves in saliva in your mouth

(c) is correct; instant coffee dissolves in hot water

(d) is wrong; here the sugar is dissolving in the water.

You will discover that there are many familiar words used loosely in everyday speech which have precise definitions in science. For example, we talk of 'Weight watchers clubs' when in fact we should be using the term mass instead of weight. Shiny metal foil is usually called 'tinfoil' although it is made from aluminium not tin.

Here is a list of other familiar or everyday words that you have learnt have a scientific meaning during your study of *Into Science*.

Module 1: product;

Module 4: reflect, wavelength;

Module 5: element, compound;

Module 7: respiration;

Module 8: energy.

You will continue to learn many scientific words as you study science. Should you use these unfamiliar technical terms when writing scientific accounts? The prime concern when writing is to make the meaning clear. So, as a general rule, excessive use of technical terms can be confusing. But in order to express the meaning accurately, you may have to use technical terms. For example, look at the two sentences (a) and (b) below about light waves.

(a) Light waves bounce off the surface of the water.

(b) Light waves reflect off the surface of the water.

Are both statements scientifically correct? They may seem to be but use of the word 'reflect' in (b) is precisely correct. Using scientific terms in your writing also has the advantage of helping you to think about their meaning.

Now try the following SAQs which are a useful revision exercise in the meaning and use of technical terms that you have met in *Into Science*.

SAQ 1 Rewrite the following sentences replacing the italicized words with a scientific term.

(a) Interest on this type of bank account is estimated as a *fraction of the total sum expressed as a given number of hundredths*.

(b) Limestone is a rock formed from the remains of marine animals that have become *preserved in rock*.

(c) Oil floats on the surface of water because water is *heavier* than oil.

SAQ 2 Rewrite the following sentences replacing the italicised phrase with a scientific word.

(a) The length of the *side of a right angled triangle opposite the right angle* can be determined using Pythagoras' theorem.

(b) Air is mainly composed of molecules of nitrogen, oxygen and carbon dioxide, the first two being elements and the latter being a *substance*.

(c) *In the absence of oxygen,* respiration can occur to a certain extent in muscle cells when they have a lot of sustained work to do.

2.2 SENTENCES

Just as it is easier to use simple words it is also easier to use simple sentences.

☐ Read the following two sentences which have the same meaning and decide which is easier to read.

(a) Dissolution of the iodine in the solvent was achieved upon elevation of the temperature.

(b) Iodine dissolved in the solvent on warming.

■ We think you will agree that the simple direct sentence in (b) is easier to read and to understand than (a).

In order to write simple, clear sentences you need to be clear about the meaning of what you want to say.

☐ Try this for yourself by rewriting each of the following sentences in a simpler form:

(a) Removal of the surface grime was accomplished by treatment of the metal with an abrasive.

(b) Cessation of combustion was instrumental in diminishing the temperature.

■ (a) The metal was scraped (or rubbed) clean.

(b) After it stopped burning, it got cooler.

Did you notice how difficult it was to understand the original sentences? Before you could rewrite them you had to interpret their meaning. This emphasizes the fact that simple direct sentences are easier to understand. They enable the reader to concentrate on what is being said and follow the argument rather than having to unravel the meaning.

Now look at the following passage that was written by a student studying a foundation course in science.

☐ Try to work out why the passage is difficult to understand.

'The tin was a silvery colour and when mixed with iodine it gradually started to go a greyish-black colour and after heating together during the experiment, iodine (which was reacting with tin) went dark orange to pale orange and then colourless.'

■ All the information is given in one long sentence.

☐ Now try to rewrite the same passage but using more than one sentence and keeping the same order of ideas.

■ *This is our attempt.* 'When the silvery tin was mixed with the iodine it gradually started to go a greyish-black colour. After heating together, the iodine went dark orange then pale orange and finally colourless'.

By breaking the passage up into shorter sentences it is easier to read. So if you want your writing to be clear, avoid using long sentences. Keep them short and simple.

Avoid using long sentences!

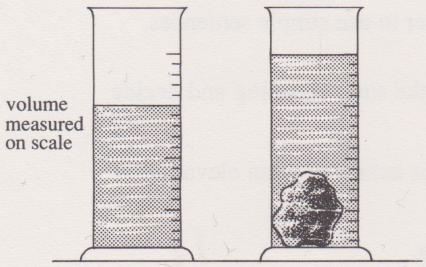


FIGURE 1 Finding the volume of an irregular shaped object.

SAQ 3 Try breaking the following passage into shorter sentences (you may have to change one or two words). Figure 1 might help you decipher the passage! Remember that density = mass/ volume

'Finding the density of a rectangular object is very easy but finding the density of an irregular object such as a broken stone is difficult because in this case measuring the volume cannot be done directly so it is found by measuring the volume of water that the object displaces which is done by measuring the difference in the height of water before and after the object has been immersed in a measuring cylinder.'

2.3 AMBIGUITY

So far sentences have been considered in terms of their length and complexity. Consider now the order of words in a sentence. The correct order of words is essential to convey the right meaning or ambiguities may arise. When a phrase or sentence is **ambiguous** it has more than one meaning.

Try this example: 'The eggs collected were graded according to the date they were laid by the farmer'.

☐ (a) What do you think was the intended meaning of this sentence?

(b) What do you think is the meaning of the sentence as written?

■ (a) The intended meaning was that the eggs were collected and graded by the farmer.

(b) It reads as if the farmer laid the eggs!

☐ Try rearranging the above sentence so that it is unambiguous.

■ 'The collected eggs were graded by the farmer according to the date they were laid'.

Try one more. 'I have discussed the plan for restocking the larder with my staff in the kitchen'.

☐ (a) What do you think was the intended meaning of this sentence?

(b) What do you think is the meaning of the sentence as written?

■ (a) The intended meaning was that there had been discussions with staff about restocking the larder with food!

(b) It reads as if the staff will be used to restock the larder!

☐ Try rearranging the sentence so that it is not ambiguous.

■ 'I have discussed with my colleagues in the kitchen the plan for restocking the larder'.

Make sure you get the word order correct!

So make sure you get the word order correct. The rule for this is as follows:

> Words most closely related to each other should be placed as near to one another as possible.

Ambiguities can also arise from the omission of commas as the sentence below shows.

'The guest speaker gave a lecture on controlling the flow of liquids to students at Reading Summer School'.

□ (a) What do you think was the intended meaning of this sentence?

(b) What do you think is the meaning of the sentence as written?

■ (a) The intended meaning was that the speaker gave a lecture to the students about controlling the flow of liquids.

(b) It reads as if the lecture was about the flow of liquids to students! (Perhaps she was suggesting a reduction in licensing hours!)

The sentence could be made clearer by adding a comma as follows.

'The guest speaker gave a lecture on controlling the flow of liquids, to students at Reading Summer School.'

However, it would be even clearer to rephrase the sentence so that words most closely related are as near to one another as possible.

□ Try this for yourself.

■ At Reading Summer School, the guest speaker gave a lecture to students on methods of controlling the flow of liquids'.

SAQ 4 The sentences below are ambiguous. Determine the two meanings for each sentence and rewrite each to avoid confusion.

(a) 'The acid burned his hand which was odourless and colourless'.

(b) 'Students north of the border keep their teeth longer than from the south'.

(c) 'An account of how senior employees are broken down by age and sex is given below'.

This Section has considered a number of features that should help you to write clearly. As a general rule short direct sentences that use simple words are clearer than long sentences that use complex long words. You also need to bear in mind the use of scientific words and phrases that have a precise meaning. This Section has also alerted you to some of the pitfalls of ambiguities and how to avoid them.

2.4 WRITING CONCISELY

This Section moves on to another important feature of good writing: conciseness. In Section 1.1 it was suggested that in order to write concisely and to make the meaning clear you should remove any **redundant** (unnecessary) words and phrases. For example, look at the following phrases that can be replaced by a single word:

(a) 'for the reason that' could be replaced by 'because'

(b) 'it being the case that' could be replaced by 'because' or 'since'

(c) 'along the lines of' could be replaced by 'similar to' or 'like'.

GUIDED EXERCISE 1

This exercise shows you how important it is to remove redundant words and phrases and how this process contributes to conciseness. Sam wrote two paragraphs in answer to the question below. His response is shown in the Box. Your task is to improve and shorten what he wrote.

Read Sam's answer two or three times and see if you can identify any words and phrases which are redundant or that could be replaced by a single word or shorter phrase. Use a pencil to mark the passage crossing out redundant phrases and inserting replacement words at appropriate places in the text.

Question: **Give a brief explanation for the shape of the graph in Figure 2 which shows the number of yeast cells growing in culture. (This figure is reproduced from Module 7.)**

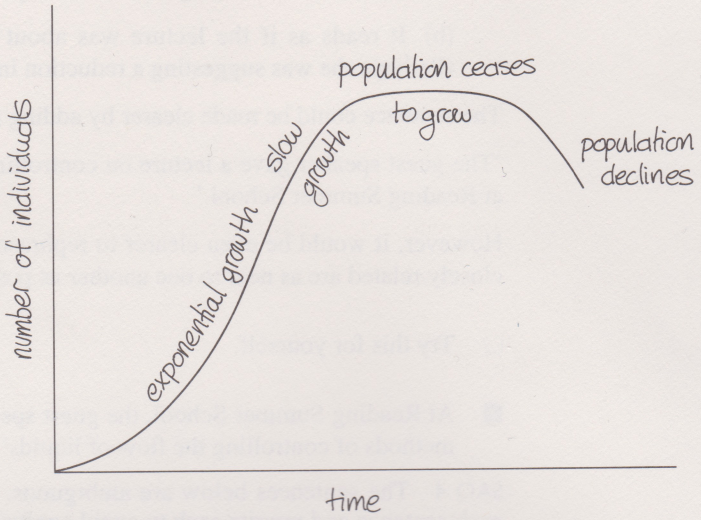


FIGURE 2 Number of yeast cells growing in culture.

Sam's answer:

As the graph of number of individuals when it is plotted against time begins as an exponential curve which flattens out before decreasing again, its highest point is where the number of yeast cells is greatest. The number of individuals at the highest point is the maximum that can grow in that quantity of food. The number of cells flattens off at its maximum when there is no increase in the number of individuals.

After this maximum number of cells the graph decreases because some of the cells begin to die. If the time scale had been left longer then eventually the graph would reach the x axis because all the cells would be dead because all the food had been used up. (124 words).

The following is our attempt to rewrite the answer by removing redundant words and replacing phrases with single words or shorter phrases:

Sam's amended answer:

The graph of number of individuals plotted against time begins as an exponential curve, reaches a point where it flattens out before decreasing again. The number of individuals at the highest point is the maximum that can grow in that quantity of food.

After remaining at this maximum the number of cells decreases because some of them die. In time all the cells would die because all the food had been used up. (73 words)

Note the substantial reduction in words. Compare your answer with ours. Did you reduce the number of words by a greater amount than we did?

The next Box shows you how we marked up Sam's original answer. The words we would remove are in *italics* and words we would add to replace phrases are in **bold.**

How we amended Sam's answer:

As the graph of number of individuals *when it is* plotted against time begins as an exponential curve *which* **reaches a point where it** flattens out before decreasing again, *its highest point is where the number of yeast cells is greatest*. The number of individuals at the highest point is the maximum that can grow in that quantity of food. *The number of cells flattens off at its maximum when there is no increase in the number of individuals.*

After **remaining at** this maximum **the** number of cells *the graph* decreases because some of *the cells begin to* **them** die. *If the time scale had been left longer then eventually the graph would reach the x axis because* **In time** all the cells would *be dead* **die** because all the food had been used up.

Remove anything redundant!

The reduction in words was achieved in two ways:

(a) Most of the eliminated words were phrases that repeated information.

(b) The shortening of the last paragraph was accomplished by adding the phrase **in time** which replaced 18 words without loss of meaning.

To summarize, the following changes to text contribute to conciseness:

- removing repeated words and phrases
- using short phrases or single words to replace long phrases.

Is the shortened version easier to read? Is it clearer even though it is more concise? We hope you agree that this is the case. So conciseness helps and improves clarity.

There is of course no single correct answer for this Guided Exercise. You may well have produced a better version than we did!

The following SAQs provide more practice in writing concisely:

SAQ 5 Rewrite the following statements removing unnecessary words and phrases.

(a) The colour of the solution changes from the violet colour of iodine to a clear orange colour.

(b) The chemical energy of the coal is converted into heat energy and kinetic energy and sound energy.

(c) When oxygen combines with iron it forms rust which is a compound of iron and oxygen.

SAQ 6 Try to shorten the following sentences either by replacing phrases with single words or by rewriting.

(a) The liquid in the container changes from a violet colour to a clear fluid.

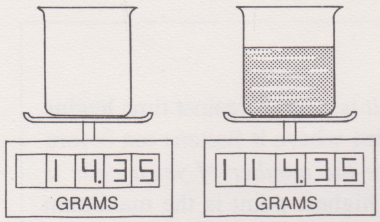
(b) Vapours which rose to the top of the container were purple in colour.

2.5 IDENTIFYING AND DEVELOPING COHERENCE

This Section considers the third feature of good writing: coherence. In some ways this is the most difficult of the three features of good writing to learn. But when is coherence important and how is it achieved? Try the following exercises to help you answer these questions.

GUIDED EXERCISE 2

This exercise involves a set of instructions on how to measure the mass of water. The instructions are given in the wrong order. Decide on the correct order of the instructions by referring to Figures 3a to 3c.



(a) (b)

(c) 114.35 g – 14.35 g = 100.00 g

FIGURE 3 Measuring the mass of water.

1 Subtract the mass of the container from the mass of the liquid and the container together.

2 Find the mass of the liquid and container together.

3 Find the mass of the container.

□ What is the correct order of the above instructions?

■ The correct order is 3, 2 and finally 1.

Having determined the mass of the water you can work out its density. Try to put the following three sentences in a logical order.

1 Calculate density = mass/volume

2 Pour the liquid into a measuring cylinder to find the volume

3 Density of water = 1 000 kg m^{-3}

□ What is the correct order of the above instructions?

■ The correct order is 2, 1 and 3.

In fact the standard mass of the kilogram was originally chosen so that the density of water would be 1 000 kg m^{-3}

The above exercises were relatively straight-forward in that it is easy to see the practicalities of the correct order for a set of instructions. But coherence has a broader meaning than this. Now try the following exercise.

GUIDED EXERCISE 3

Read the following two sentences about light waves.

Different waves are usually described according to their wavelength. Radiation can travel through space in the form of waves.

Is the material presented with a well thought-out sequence, each point logically flowing from the last? Let's analyse the information carefully. The first sentence is about waves. What kind of waves, water or radiation? The next sentence gives

us a clue by introducing the idea of radiation. So the order of information is wrong. Let's try reversing the order of the two sentences.

> Radiation can travel through space in the form of waves. Different waves are usually described according to their wavelength.

☐ Is this more logical?

■ It appears to be so, since the first sentence introduces the idea of radiation and waves. The second describes the waves in more detail. The first sentence gives the introductory information that is required for the second sentence to have any meaning to the reader.

GUIDED EXERCISE 4

Try another example, again about waves.

> 1 Humans are able to harness radiation and light waves and put them to a variety of medical uses.
>
> 2 X-rays are used in medicine and dentistry to help visualize the internal hard parts of the body such as bone and teeth.
>
> 3 Infrared waves were used in the treatment of arthritis.
>
> 4 Ultraviolet can be harmful in large doses although at one time it was used for treatment of severe acne.

☐ Are the ideas in the four sentences presented in a logical order?

■ Yes, the first sentence introduces the topic and each of the following three sentences provides an example. These last three sentences could go in any order.

2.5.1 IDENTIFYING LINKS

So far you should appreciate that when writing coherently you need to give some thought to the order in which you present information or ideas. To decide on an order you need to identify links between the ideas or information. There are a number of ways that this can be done and some people prefer one method to another.

GUIDED EXERCISE 5

The aim of this exercise is to help you identify links between ideas and information. One way of making links is to identify linked pairs.

☐ Try to identify linked pairs in the following question about the water cycle.

Question: **Explain the relationship between the following: rain, rivers, seas, clouds and groundwater.**

■ The pairs we identified are: rivers–seas, rain–groundwater, seas–clouds, clouds–rain, groundwater–rivers (there are others).

☐ Now place them in a logical linear sequence.

■ One possible linear sequence is: rain–groundwater, groundwater–rivers, rivers–seas, seas–clouds, clouds–rain.

Such a sequence can form the basis of your answer.

Sometimes *patterned* notes work better than linked pairs in enabling you to see all the links and connections. In this case the title or topic is written in a bubble in the centre of the page. Then working in a clockwise direction, major points or themes are written along lines radiating from the centre. Subsidiary points branch off from these main points as appropriate, as shown in Figure 4.

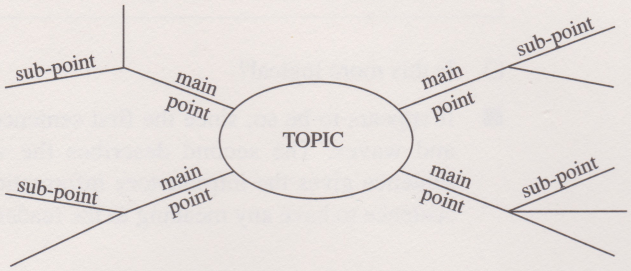
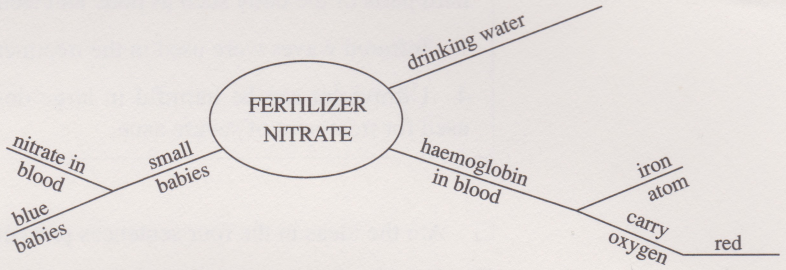


FIGURE 4 Pattern notes.

□ Try producing pattern notes for the following question:

Question: **Explain the relationship between nitrates in drinking water and blue baby syndrome.**

■ Here is one possibility:



Once the pattern is completed, all the information you want for your writing is readily available, and you can see at a glance the various routes available to write an answer. So pattern notes help you to plan the order in which you present ideas or information. For example, look at the answer to the last ITQ. You can see there are three main points centred around the topic, nitrate.

□ How would you order the three main points in your answer?

■ We chose, drinking water, haemoglobin and small babies. You may have chosen another order for your answer.

It is important to remember that there is frequently more than one way to order ideas and information.

Section 2.5 has shown how coherence can be achieved. It is important that the ideas or information is presented in a logical order. The following SAQ gives you more practice in identifying and developing coherence.

SAQ 7 Rearrange the following sentences (just one shift is needed) to make a coherent account.

'The metal magnesium burns brilliantly in air. Most metals combine with oxygen; some even do this without being heated. You have probably seen this flame in old-fashioned camera flash-bulbs or in firework displays.'

2.6 IS MY WRITING EASY TO UNDERSTAND?

This short Section gives a few practical tips that you can use to test whether your writing is clear, concise and coherent.

Is my writing easy to understand?

First, you may find it helpful to re-read your answer after a gap of a day or two. This way you can come to it fresh with your mind uncluttered by all the thoughts you had when you were producing the first draft. This is a particularly useful technique for identifying jumps in logic.

Another way is to read it out loud to yourself and listen carefully to what you are saying. If you find that you stumble or hesitate, it might mean that you need to rewrite a sentence to make it clearer or that you need to add a word or phrase.

Better still, read it to a friend and ask her or him whether it is clear and logical.

> If you are uncertain of the clarity, try reading it aloud.

3 MORE THAN MERELY WORDS

The last Section has looked at the skill of good writing. The next two Sections focus on the skill of answering questions in assignments.

When answering questions the overriding rule is *be clear what is expected of you*. You may have the impression at this stage of your studies that all answers in science are descriptions. Is this true? The following examples of questions illustrate that this is not so.

Compare the processes involved in the production of igneous rocks with those that lead to the production of metamorphic rocks.

Distinguish between the composition of igneous rocks and that of metamorphic rocks.

Discuss the similarities and differences between the structure of plants and that of animals.

In each of the three examples the verb or doing word has been italicized. These words tell you what you have to do. (You will be given more help with the meanings of such words later in your studies.)

Another important task is to consider what to include in your answer. What other features help to make your answers clear? Diagrams and sketches not only make scientific writing easier to understand but can also save a lot of words! The rest of this Section looks at the use of diagrams and other features that make your answers clear.

3.1 MATHEMATICAL ANSWERS

Let's begin with a question that includes some maths.

GUIDED EXERCISE 6

Consider the following question.

Question: **How many kJ of energy would there be in an 850 g pot of yoghurt if 3.5 oz contained 198 kJ? (Note 3.5 oz (ounces) is approximately 100 g.)**

- ☐ Are you clear about what you have to do?
- ■ Clearly the answer to this question would require you to carry out some mathematics.

Try answering this question for yourself (you may need to refer back to Module 8) and then compare your answer with that of Ewart's and Jo's overleaf.

Ewart's answer:

Since 100 g equals 3.5 oz, an 850 g pot of yoghurt contains 8.5 lots of 3.5 oz and 3.5 oz contains 198 kJ

Therefore 8.5 × 198 kJ = 1 683

An 850 g pot of yoghurt contains 1 683 of energy.

Compare this with Jo's answer.

Jo's answer:

An 850 g pot contains 8.5 lots of 3.5 oz

An 850 g pot of yoghurt contains 1 683 kJ of energy

Are both answers the same? It is true that they have both arrived at the correct mathematical answer but both have omitted to show something.

Mathematical answers must include all stages of the calculations.

- ☐ Can you see what Ewart has omitted from his answer?
- ■ He has omitted the units; this is a common error!

- ☐ Can you deduce what is missing from Jo's answer?
- ■ Jo has not given all the calculations to show how she arrived at her answer.

These observations you have just made about answers that require mathematics are very important ones.

Mathematical answers must give units and include all stages of the calculations.

Let's use these observations to produce a correct version:

Since 100 g equals 3.5 oz, an 850 g pot of yoghurt contains 8.5 lots of 3.5 oz and 3.5 oz contains 198 kJ

Therefore 850 g yoghurt contains 8.5 × 198 kJ = 1 683 kJ

An 850 g pot of yoghurt contains 1 683 kJ of energy.

One advantage of including the calculations is that it is possible for your tutor to see where you might have gone wrong and to give you credit for a correct approach or partially correct work.

3.2 ANSWERS THAT INCLUDE CHEMICAL EQUATIONS

The question in Guided Exercise 6 made it clear that you had to carry out some maths. But not all questions make it quite so obvious as to what might be included in the answer, as the next Guided Exercise shows.

GUIDED EXERCISE 7

Question: **Describe the process of photosynthesis in green plants. (Answer in no more than 100 words.)**

First look at the word 'describe'. What does this mean? Describe means give an account. The other important words are 'process of photosynthesis', which tell you what you have to write about. What would you include in your answer in addition to words? Try writing a draft of your own (you may need to refer back to Module 7) and then compare your answer with that of Nicky's and Ruth's below.

Nicky's answer:

The process of photosynthesis describes the way that green plants obtain their food.

carbon dioxide + water $\longrightarrow$ sugar + oxygen

This word equation can be written as a chemical equation:

$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

The chloroplasts use light energy to make the sugars.

Compare Nicky's answer with Ruth's below.

Ruth's answer:

The process of photosynthesis describes the way that green plants obtain food. The process occurs in the chloroplasts which trap energy from light. Plants use light energy to combine carbon dioxide with water to produce sugar, with oxygen as a side product. The process can be described by the following equation:

carbon dioxide + water $\longrightarrow$ sugar + oxygen. This word equation can be written as a chemical equation:

$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

Did you include the equation for the process of photosynthesis in your own answer? You could well save yourself a lot of writing and a lot of time if you had included it. So when planning your answer think about what you need to include other than words.

Both Nicky's and Ruth's answers are good. Now look at them in detail. Both answers appear similar, although Ruth's is a bit longer. But is that the only difference? Both answers give an equation, but do they do it effectively? Nicky's answer does not tell the reader what the equation is; it assumes the reader knows that this is the process of photosynthesis. However, Ruth's answer explicitly tells the reader what the equation is. Furthermore, Nicky's answer only gives the basic information about the process of photosynthesis in the equation; he does not describe it in the text. In contrast Ruth gives the basic information in the text and uses the equation to give the details. In summary, Ruth's answer has made the equation an *integral* part of the text using it to illustrate a point in the text. You should try to do this, not only for equations but also for other items such as calculations. This is a very important point that you need to remember and practise:

Equations and calculations should be integrated into the answer and not treated as an add-on.

So some answers may be a mixture of words and calculations or a mixture of words and equations. Are there other possibilities?

3.3 ANSWERS WITH DIAGRAMS

The inclusion of diagrams and drawings in an answer can save a lot of words! Try the next exercise for yourself.

GUIDED EXERCISE 8

Question: **Describe the structure of a molecule of carbon dioxide.**

Are you clear what you have to do? What might you include other than words? Write your own answer (you may need to refer to Modules 5/6) and then compare it with Chris's.

Chris's answer:

A molecule of carbon dioxide consists of a carbon atom and two oxygen atoms. Each of the oxygen atoms are attached to the carbon atom. Since carbon can form four bonds and oxygen two bonds, each oxygen atom is linked to the carbon atom by two bonds. This relationship between the atoms is shown in Figure A.

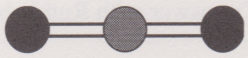


Figure A.

Such bonds are called double bonds.

The answer to this question has been made clearer by the use of a diagram.

☐ Is the diagram an integral part of the text?

■ It is.

☐ There is something missing; can you spot what it is? If you have difficulty in answering this question compare the above answer with the corrected answer below.

Chris's corrected answer:

A molecule of carbon dioxide consists of a carbon atom and two oxygen atoms. Each of the oxygen atoms are attached to the carbon atom. Since carbon can form four bonds and oxygen two bonds, each oxygen atom is linked to the carbon atom by two bonds. This relationship between the atoms is shown in Figure A.

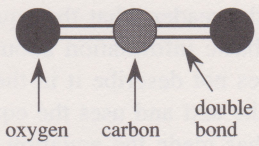


Figure A The structure of carbon dioxide.

Such bonds are called double bonds.

■ Chris had forgotten to label the diagram; he had assumed the reader would work it out.

You have just arrived at an important point about the use of diagrams; they should be fully labelled if they are to convey meaning to others.

All diagrams should be fully labelled.

Now review the three boxed rules you have learnt in Section 3 and try to bear them in mind when answering questions. You may save yourself a lot of time! Try using them by doing the following SAQs.

SAQ 8 Describe the conversions of energy that occur when a man digs a hole in the ground with a spade.

SAQ 9 Assuming the volume of a water droplet to be $1 \times 10^{-7}\ m^3$ and that of an individual molecule to be approximately $10^{-27}\ m^3$, determine the number of molecules in the water droplet.

SAQ 10 You learnt in Module 3 that lime is used to make cement. Lime, CaO, can be made from limestone, $CaCO_3$, by heating it in limekilns. Compare these formulae and suggest what may be the other product making clear your reasoning.

4 HOW TO SET ABOUT WRITING AN ACCOUNT

Now that you have learnt the important elements of good writing in science this Section considers how to answer questions that require you to write an account. Section 4.1 gives you some hints on how to tackle writing an account. Section 4.2 gives you a question to tackle for yourself and looks at two students' answers. We also had a go at answering the question. Our attempt is given in Appendix 2 at the end of the Module.

Before looking at how to tackle a question let us look at some general aspects of writing accounts. The first point to note is that they vary in length. A short account may only be a paragraph. In contrast, a long account or essay might be about 1 000 words long (approximately 3 sides of A4 paper). Short answer questions usually clearly define what is required of the answer; in contrast longer accounts are more open-ended. Compare what is required of you in the following two questions.

Question 1: Describe the types of energy conversions used in a game of squash between two players played after dusk. (Answer in 150 words)

Question 2: Describe the biological and geological evidence for and against the evolution of human beings. (Answer in 1 000 words)

Short answer questions or short accounts are in general easier to tackle than longer accounts or essays. However, short answer questions can present a different kind of problem in that it is sometimes not easy to see how much information or discussion to include. In fact, the question might well be set in order to test your ability to select the essential features. The following example illustrates the point:

Question: Describe in 100 words the important features of a galaxy.

So writing a short account can have its difficulties! It is important to make certain that you understand what is required.

The essential feature of an account is that it should have a *structure*. Section 4.1 shows you how to achieve this by giving you some practical hints on how to approach and prepare an account.

4.1 HINTS ON HOW TO TACKLE AN ACCOUNT

The approach in this Section is useful when writing either short or long and more complicated answers. There are 5 steps to follow, starting with reading the question and finishing with producing a final version of your answer. These are shown in the Box.

STEPS IN PRODUCING AN ACCOUNT

1 *Read* the question carefully and make sure you understand what you have to do. Underline the important words.

2 *Collect* the information from the course texts. Could you usefully include diagrams or formulae?

3 *Organize* the information into an order so that one point flows on to the next. This step is essential if you want to produce a coherent account. The best way to do this is to *plan* the sequence before you start to write. This will involve you thinking carefully about the relationship and links between each of the facts or concepts you have collected. You may need to check the text again to make sure that you understand it.

4 *Write* your answer following the order of your plan.

5 *Review* your answer. If necessary *rewrite* the sentences to make the meaning clear and to improve the conciseness of the whole account.

It is important that you keep to the order of the plan!

PUTTING THE STEPS INTO ACTION

Below we consider each of these 5 steps in turn.

1 Reading the question

Before starting to answer the question, make sure you are clear about what is required of you. First, check what is meant by the key verb in the question. You may be asked to *describe*, *discuss*, *compare* or *evaluate*, for example. Second, check the other important words that set the boundaries of what you have to write about. One way of focusing on the points you need to think hard about is to underline the important words.

2 Collecting the information

There are a number of ways that the information can be collected. You can read the text, extracting the relevant points and writing them in note form. Alternatively, you can underline the appropriate words and phrases in the text as you learnt in Modules 1 and 3. Decide which diagrams, equations or formulae to include.

3 Planning and organizing

Now that you have collected the relevant information from the course texts you can go on to the next step which is to produce a structured plan. A plan is written in the form of topics or headings in the order they will appear in the account. To get a logical order you need to identify links as you learnt in Section 2.5.1. Decide where to insert diagrams or formulae.

The process of organizing the material can be split into a number of further steps. A long scientific account has a definite structure to it. You will find that being aware of this structure can also help you plan a short account. The structure is as follows:

- INTRODUCTION

Even a short account of one paragraph in length needs an introduction. As a general rule the introduction should define or explain the subject you are writing about and the aim of the account.

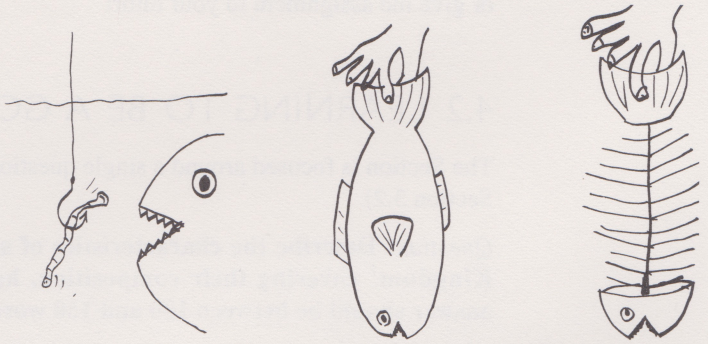
- MAIN BODY

The main body forms the bulk of the answer and contains the content or information. It is important to arrange this in a logical order at the planning stage.

- CONCLUSION

When writing a long account the conclusion may be a very important part of the answer. In the case of a short answer there may be no conclusion to draw. Nevertheless, it can be useful to include a concluding sentence; it rounds off the answer and brings it to a close rather than leaving it up in the air. A conclusion sums up the main ideas. It also shows whether you have achieved the aims of the account. The conclusion might influence the structure of the main body of the answer.

At the end of step 3 you should have worked-out a plan for your account.



The structure of an account!

INTRODUCTION MAIN BODY CONCLUSION

4 *Writing the first draft*

Having produced your plan the next step it to use it to write your draft. It is important at this stage to ensure that you keep to the order of the plan.

5 *Reviewing and redrafting*

The last stage is to redraft the account to improve the clarity and length (conciseness). This reviewing process is essential because you are bound to have made some mistakes.

Redrafting also gives you an opportunity to produce a neat clean draft for your tutor to read. This means that you can afford to make mistakes in your first draft, because at the review you can insert phrases and cross-out others. Only you will be reading this version. Because your first draft is only a rough copy, you can afford to experiment with ideas. Some of these may not work well. On the other hand, if you try out different approaches and styles, you can give yourself the opportunity to improve your writing techniques.

Below is a checklist for you to use to review your account. However, you might also refer back to this checklist on later occasions when you write assignments.

REVIEW CHECKLIST

Is the account the right length—both according to the word limit set and for its own purpose?

Are there any repetitions or unnecessary words or phrases?

Does it answer the question set?

Have any points been omitted?

Have relevant diagrams and formulae been included?

Are the points covered in sufficient depth?

Is the material arranged logically? Or does the answer need restructuring?

Is the meaning clear?

Is the account neatly and legibly written?

However, you may welcome a word of caution at this stage. Redrafting is an important stage in the writing process but it is possible to endlessly redraft and so spend a lot of time on each question. You must decide at some stage to send or give the assignment to your tutor!

4.2 LEARNING TO BE A GOOD JUDGE

The Section is focused around a single question about rocks (based on Module 3, Section 3.2).

Question: **Describe the characteristics of sedimentary rocks in the United Kingdom[1] covering their composition, hardness, colour and age. (Your answer should be between 100 and 150 words long.)**

You will gain most benefit from studying this Section if you try to answer the question for yourself. We suggest that you have a go at producing your own answer using the hints given in Section 4.1 as a guide. Try to do this now.

We go on to look at two student's answers to this question, Carl's and Pat's. These were adult students studying an introductory science course. Although their answers were handwritten they have been typed for ease of reading. To help you get a further measure of writing skills we have provided detailed comments on their answers.

Finally, have a look at how we answered the question. Each of the five steps of our answer is given in Appendix 2 along with more details on the practicalities of tackling a question of this type.

Have you completed your own answer? Now read Carl's and Pat's answers.

[1] The United Kingdom (UK) is the political entity of England, Northern Ireland, Scotland and Wales. Britain includes England, Scotland and Wales. The British Isles includes England, Scotland, Wales and the whole of Ireland.

Carl's answer:

Large areas of the UK are made up of sedimentary rocks, such as sandstones, limestones and clays. Sedimentary rocks are so called because they are made up of sediments such as bits of sand and fossils. Sometimes their colour is white and sometimes red-brown. The sediments can have different sizes. Some were laid down 570 million years ago whereas others are quite young being laid down up to 65 million years ago and yet others have an age between these two extremes. In general younger sedimentary rocks are found in the south-east of England and southern Ireland and the older ones are found in south Scotland and in the east of Northern Ireland. Some sedimentary rocks have become metamorphosed. (118 words)

Pat's answer:

Sedimentary rocks are formed by the laying down of sediments in a desert or a river. Since this is a continuous process and has been since the formation of rocks began, their age varies widely. The ones in the United Kingdom were all formed at sometime in the last 500 million years or so. The rocks are made of particles of sand or quartz and these vary in size and shape. The particles become stuck together over time to produce a rock. They have a variety of colours, white, cream, red-brown, honey-coloured and pale coloured. Some sedimentary rocks are hard. These make better building material whereas soft rocks more easily break up. (102 words)

Before going on to read how we assessed these answers, have a go at assessing them yourself. This is not an easy activity to carry out. But try to use this exercise as a way of learning what makes a good short account. If you answered the question yourself you will have three attempts to mark. For each answer write your comments against each of the points listed in the Table. (The list is based on the checklist given on page 20.) Tick or cross items and include comments such as: done well, very good, weak, could be better. Having completed the table, try to formulate an overall impression of how good each answer is. Complete this exercise *before* going on to read our comments on the answers.

Checklist of points	Carl's answer	Pat's answer	Your answer
1 Is the account the right length — both according to the word limit set and for its own purpose? This is a test of *conciseness.* Did it answer the question set? 2 to 6 below: 2 Did the answer *describe*? 3 Was the answer confined to *sedimentary* rocks? 4 Was the answer confined to rocks in the United Kingdom? 5 Were all *four* characteristics described? 6 Was each of the characteristics covered in sufficient depth or were there omissions? composition hardness colour age 7 Was the information arranged logically? Or does the answer need restructuring? This is a test of *coherence.* 8 Was the answer clearly expressed and easy to understand? This is a test of *clarity* 9 Overall impression			

The comments that follow on each of Carl's and Pat's answers are much fuller than you could be expected to put in the table because we have backed our criticisms with reasons. It is very important to note that we have been very critical in our comments because we are trying to show how each answer could be improved.

COMMENTS ON CARL'S ANSWER

1 He has kept to the word limit.

2 Yes, he has concentrated on describing but has included some irrelevant details in the last two sentences.

3 In general he confined his answer to sedimentary rocks but he also included an unnecessary reference to metamorphic rocks.

4 In general he confined his observations to the UK but he also referred to Eire which would not have gained him any marks.

5 Only three characteristics were included, he omitted hardness.

6 Composition was dealt with briefly; there was no mention of different sizes of particles, whereas, *pebbles, much finer grain size* are descriptions given in the text. Also he made no mention of shape such as *very rounded grains.*

Hardness was not included.

Colour although included was weak, the variety of colour was omitted.

Age was particularly well done, and information not written in Module 3, but given in the map, was included. This shows that he was using the diagrams (map) as an integral part of studying.

7 The answer started well in that he set out to explain what sedimentary rocks are, in order to orientate the reader. On the other hand, he did not really succeed fully. A better definition would have provided the necessary background to understanding their composition. It could also have been better organized; it jumped from composition to colour and back to composition.

8 The style is clear and easy to understand but it does read rather like a list of points. However, it is unfair to be too critical about this because the question simply asked for a description.

9 The overall impression is that Carl needed to spend some more time planning the answer. He lost marks by not re-reading the question and consequently he omitted to mention the characteristic, hardness. He had not checked the balance of the information in the answer; there is an excess of detail on age of rocks and by comparison the other characteristics are dealt with rather thinly. Also the last two sentences are strictly not required in the answer, so he wasted precious words on irrelevant information.

COMMENTS ON PAT'S ANSWER

1 She has kept to the word limit.

2 Yes, she has concentrated on describing, though some information about building materials is mentioned even though this is not required in the answer.

3 Yes, Pat confined her description to sedimentary rocks.

4 She confined her description to the UK.

5 All four characteristics were included.

6 Composition was mentioned but the description was confined to sandstones, other types such as limestones (with fossils) and clays were omitted.

Hardness was well covered.

Colour was particularly well done giving the reader a clear description of the variety.

Age was covered well. She had clearly grasped the point that the process of formation of sedimentary rocks is a continuous process thus explaining the diversity of age.

7 The answer started well giving the reader a general description of what sedimentary rocks are. Part of it was well organized in that she had tried to develop a flow. For example, the point about variety of age logically flows from the point about continuity of the process of rock formation.

In the second half (beginning, 'The ones in the UK....') she has taken each characteristic one at a time. But it flows less well than the first half because new points do not follow from the preceding point. However, it is not always easy to find links and connections between points to help the flow. For example, the characteristic of colour is not related to the age of the rock nor is the colour of sedimentary rocks related to the hardness of the rock.

8 The style is clear and easy to understand.

9 The overall impression was that Pat had spent time not only deciding on the content of the answer, but also on the organization of the material in the first half. The answer could be improved by giving a fuller description of composition.

As noted at the beginning we have been extremely critical in our comments of the two answers. Of course, each answer has its individual strengths as well as its weaknesses. So let's now put our comments into perspective. Bearing in mind that both Carl and Pat had just returned to study after a break, and that this was only their second piece of writing since they had embarked on an introductory science course, how do we rate their answers? Given this perspective, we thought they were very good!

When you submit a piece of written work your tutor will provide comments on the content and style of your answer. Some of these may seem critical but it is

important to remember when you read them that your tutor is trying to help you to improve your writing skills.

Did you write a similar set of comments on your own answer? If not, why not do so now. How did your attempt compare with that of Carl's and Pat's? Did you omit any important points? What were the strengths of your answer? How do you think it could be improved?

You can see in Appendix 2 how we approached writing the answer. It describes how we followed the 5 step plan and gives more practical hints on writing accounts.

4.3 HINTS ON SCORING POINTS

So far in Section 4 we have given you hints on how to set about writing scientific accounts. If you follow these hints you will not only produce clearer answers but you will gain more marks. But there is a further source of clues that can help you gain more marks which we make you aware of here.

Often included with the question are hints and clues about the allocation of marks. *Do* make the most of these clues. For example, you may have two questions to answer in an assignment, the first is worth 70% of the marks and the second 30% of the marks. To which of these questions should you devote more time in planning and preparing your answer as well as writing it? The mark allocation suggests that the marker will be expecting more of an effort from you in the answer to the first question and will be looking out for evidence of this.

There may be more helpful explicit statements in the assignment such as:

... your answer should be no more than 100 words long and include a diagram.

... your answer should include two examples of chemical energy being converted to kinetic energy...

... marks will be awarded for clarity of style.

You need to take note of such hints and act on them. What is essential for you to bear in mind is that tutors have mark schemes as a guide to allocating marks. In the first of the three statements above, marks will be allocated for including a diagram. You may be surprised to learn that some students do not include diagrams in their answer to such questions. In the second statement, marks will be allocated and therefore awarded for *each* example—yet sometimes students only include one example.

□ In the case of the last of the three statements what should you do to achieve higher marks?

■ Be prepared to leave your attempt for a day or two and then rewrite it to improve its clarity.

Suppose you were asked to draw a graph using a table of data in the way that you did with your cooling curve experiment in Module 8. How might the marks be allocated? There will almost certainly be marks for collecting the data but there will be a breakdown of marks for the presentation of the graph. These are easy marks to gain if you know what is required of you.

□ Make a list of the features of a good graph.

■ You should have thought of some of the following:

Appropriate size of graph and scales of axes
Correctly plotted points
Labelled axes with units clearly stated
Neatly plotted graph
A title.

SAQ ANSWERS AND COMMENTS

SAQ 1 This is best done in several steps: first we need to calculate how much carbon is present in a tonne of coal:

From Table 1, this coal contains 85% of carbon, so one tonne of coal will contain: $1 \times 85/100 = 0.85$ tonnes of carbon.

We know (from Equation 1) that 12 tonnes of carbon will combine with oxygen on burning to form 44 tonnes of CO_2, so 0.85 tonne of carbon will form:

$0.85 \times 44/12 = 3.12$ tonnes of CO_2 (to two decimal places)

SAQ 2 60 million tonnes of coal with an average carbon content of 75%, will contain $60 \times 75/100 = 45$ million tonnes or 45×10^6 tonnes of of carbon.

We know that 12 tonnes of carbon burn to give 44 tonnes of CO_2 (see Equation 1).

Therefore 45×10^6 tonnes of carbon will give:

$$45 \times 10^6 \times 44/12 = 165 \times 10^6 \text{ tonnes of } CO_2$$

That is 165 million tonnes of carbon dioxide, or about three tonnes for everyone in the country!

SAQ 3 Temperature change for the present day (1990 AD) = 0.0 °C

Temperature change for 2100 AD = +4 °C

Therefore, rate of increase = 4/110 = 0.036 °C per year

So the comparative rates of heating are: 0.036/0.005 = 7.2

So heating up of the climate is estimated to be 7 times as fast for the next century as at the start of the so called medieval warm period.

SAQ 4 It seems that burning of fossil fuels adds about 5 billion tonnes of carbon as CO_2 to the atmosphere each year, and forest fires about another 2 billion (Figure 7).

Therefore the total amount of CO_2 added to the atmosphere from these activities each year will be:

$$7 \times 10^9 \times 44/12 = 25.67 \text{ billion tonnes of } CO_2 \text{ per year}$$

SAQ 5 The actual amounts of CO_2 added to the atmosphere each year by fossil fuel burning and forest fires are about twice as much as the increase of CO_2 in the atmosphere each year. The burning of fossil fuels alone is 5/7ths of this CO_2, plenty to account for the observed rise in CO_2 in the atmosphere.

SAQ 6 We cannot give a definite answer but you should have noted the following. It is likely that increased levels of CO_2 in the atmosphere will cause some global warming, due to the so called 'greenhouse effect'. Best estimates are that global temperatures will rise by about 4 °C by the year 2100 AD.

SAQ 7

(a) Volume of petrol used: 25 000/10 = 2 500 litres

mass of petrol used: $2\,500 \times 0.8 = 2\,000$ kg = 2.0 tonnes.

(b) Mass of carbon in petrol: $2.0 \times 0.8 = 1.6$ tonnes

mass of CO_2 produced: $1.6 \times 44/12 = 5.87$ tonnes.

SAQ 8 Fuel required (from SAQ 7(a) answer = 2 500 litres)

$\frac{2\,500}{4.5}$ gallons which = 556 gallons.

To find out the number of drums we need to divide by the number of gallons each drum holds:

$\frac{556}{44}$ drums = 12.63 drums.

So you would have to order 13 drums.

SAQ 9 Internal area of ground floor of house:

$= 9.60 \times 5.80 = 55.68\ m^2$

Internal volume enclosed by the walls

$= 55.68 \times 5.00 = 278.4\ m^3$

The area of the gable end of a roof is given by the area of the two right angled triangles of which it is made up, see Figure 20, Module 3.

The area of a right-angled triangle is $\frac{1}{2} \times$ height $\times$ width, so area of two triangles = height $\times$ width,

Height of triangle = 2.00 m

Base of triangle = $\frac{5.80}{2.00}$ m

So area of gable end = $2 \times \frac{5}{2}\ m^2$

To find the volume of the roof space multiply this area by the length:

$5.80\ m^2 \times 9.60\ m = 55.68\ m^3$

Therefore total internal volume of house = $(278.4 + 55.68)\ m^3$ = $334.1\ m^3$ (to 1 dec. place)

To find the volume of CO_2 produced in exhaust fumes use the formula:

$$\text{Volume} = \frac{\text{mass}}{\text{density}}$$

Amount of CO_2 produced in a year is 5.87 tonnes

Or, $5.87 \times 1000 = 5\,870$ kg

Density of CO_2 is $2\ kg\ m^{-3}$

Therefore, volume of $CO_2 = \frac{5\,870}{2}\ m^3 = 2935\ m^3$

To see how many house-fulls of CO_2 is produced, divide the volume of CO_2 produced by the volume of the house.

= 2 935/334.1= 8.78 house-fulls

In a year your car emits about 9 house-fulls of CO_2.

APPENDIX 1: EXPLANATION OF TERMS USED

AMBIGUOUS A phrase or sentence with more than one meaning.

COHERENCE Having a logical flow or order.

CONCISENESS Short without repetition, the opposite of rambling.

CLARITY Writing which is easy to understand.

REDUNDANT Unnecessary words or phrases.

APPENDIX 2: OUR ACCOUNT ON SEDIMENTARY ROCKS

Below is our answer to the question set in Section 4.2:

Question: **Describe the characteristics of sedimentary rocks in the United Kingdom, covering their composition, hardness, colour and age. (Your answer should be between 100 and 150 words long.)**

We followed the 5 steps given in Section 4.1 to produce an account.

1 Reading the question

☐ What words did you underline in order to focus your thoughts?

■ We underlined the verb *describe*, the word that told us what to do. We also underlined *sedimentary rocks* and *United Kingdom*. Finally we underlined *characteristics*.

The underlined words show you the limits or the boundary of the question; they help you to answer the question as set. Many students throw away marks because they do not answer the question. We now have a framework which defines the limits of the answer to be written.

> We know we have to confine the answer to *sedimentary rocks*, not igneous or metamorphic rocks. The description is confined to the United Kingdom. Furthermore we have to *describe* their *characteristics*.

2 Collecting the information

We turned back to Section 3.2 in Module 3 and underlined the appropriate bits of text, relevant to composition, colour, age and hardness. The words we underlined, given in the order they appear in the text, are given in the Box.

> small particles, sand and pebbles, 280–345 million years, pale-coloured, fossil fragments, white, cream-coloured, red-brown, 195–230 million years ago, much finer grain size, very rounded grains, honey-coloured, in the last 500 million years, younger…soft and more easily break up, hard and durable, 65–140 million years, soft, white.

3 Planning and organizing

Recall that by the end of this stage we need to produce a plan.

You may find that you need to re-read the appropriate part of the text of Module 3, including diagrams, to help you arrive at an introduction and conclusion. Let us consider what would be an appropriate introduction and a suitable conclusion for this account.

INTRODUCTION

As a general rule the introduction should define the subject we are writing about. In this case it is sedimentary rocks. Rocks are classified according to the process by which they are formed. This is how sedimentary rocks can be distinguished from other types of rock. However, the question did not ask for an explanation of how the rocks are formed so the definition of sedimentary rocks needs to be concise. In addition we also decided that the idea of the process of formation of sedimentary rocks as a continuous one was important in understanding their age so we included this point too. Since the aim of the account is to write about sedimentary rocks we felt that nothing else was required in the introduction.

> Sedimentary rocks are formed from sediments laid down in seas, rivers or deserts. The process of their formation is a continuous one.

CONCLUSION

The question we asked in order to arrive at a conclusion was, 'Why do sedimentary rocks have these particular characteristics?' And, 'How can the particular characteristics of sedimentary rocks be explained?'

□ Try to answer these questions in order to arrive at a possible conclusion.

■ We decided that the characteristics of sedimentary rocks could be explained as a consequence of the way that they are formed.

> The characteristics of sedimentary rocks, including composition, colour, age and hardness, can be explained as a consequence of the way they are formed.

THE MAIN BODY

Recall that this contains the main content of the answer. We decided to deal with each characteristic one at a time by collecting the appropriate words and phrases together.

□ Look back at the words and phrases we collected together from the Module (given in the second Box in Appendix 2) and arrange them into four groups, one for each characteristic.

■ Our answer is given in the Box below.

> We collected the following list of words for each characteristic:
>
> composition: small particles, sand and pebbles, fossil fragments, much finer grain size, very rounded grains.
>
> hardness: younger…soft and more easily break up, hard and durable
>
> colour: pale-coloured, white, cream-coloured, red-brown, honey-coloured, white
>
> age: 280–345 million, 195–230 million, in the last 500 million, 65–140 million years.

So far we have organized the material for the main body of the account into four groups, one for each characteristic. Concentrating on one characteristic at a time we decided how that information could be presented in a meaningful and concise way.

> For example, is there a range of colours or are they similar? The colours range from red-brown through yellows and creams to white.

We found at this stage that we had to check points in the text. For example, does the map and the illustrations give more information about the ages of sedimentary rocks? Were they formed at a particular period of time? According to the map there is no identifiable gap in the ages of sedimentary rocks. We also found we had to re-read the text to make sure we had the correct meaning. All the sedimentary rocks exposed on the surface in the UK are less than 570 million years old.

Next we considered the order in which to present each characteristic. To help us decide this we worked out how they might be linked together in a meaningful way.

□ Are any two of the four characteristics related or linked in some way?

■ After re-checking the text we decided that age is *generally* related to hardness. Furthermore, age is also related to the process of continuous formation. In addition, grain composition is linked to the idea of sediments. Colour did not seem to have any specific links though the text does suggest it bears some relationship to composition.

In summary these were the links we identified:

age: hardness

age: continuous formation

origin from sediments: composition of rock

colour: composition of rock

Notice that we have identified links for all four characteristics. However, some characteristics have only one link whereas others have more than one. You may prefer to produce pattern notes at this stage as you learnt in Section 2.5.1.

□ Using these links draw up a final plan for the account which includes all the topics to be covered.

■ Our plan is given in the Box below.

> Introduction: sediments laid down
>
> Composition: grains, sand pebbles and fossils, also shape of grains
>
> Colour
>
> Process of formation is continuous therefore age varies widely
>
> Hardness: in general young = soft; old = hard
>
> Conclusion: process of formation

You may have selected a different order. Remember for any piece of writing there are a number of ways of putting the information together. When producing the order ensure that:

- it flows from the introductory sentences
- the points are arranged in a logical order, each one following from the preceding one.

4 Writing the first draft

Below is our attempt.

> Sedimentary rocks are formed from sediments laid down in seas, rivers or deserts. They are made up of particles of sand, pebbles or even pieces of fossils, which vary in size and shape. Depending on the origin of the grains they vary in colour from red-brown through yellows and creams to white. Since the laying down of particles is a continuous process, the age of sedimentary rocks varies widely, although the majority in the United Kingdom were formed in the last 500 million years or so, some being as young as 65 million years old. The hardness of the rock is in general related to their age, younger rocks being softer than older rocks which are hard and durable. The characteristics of sedimentary rocks, including composition, colour, age and hardness, can be explained by their process of formation.
>
> (138 words)

There is an important feature to note about this answer. Notice how we used the phrase *since the laying down of particles is a continuous process*. We used this as a linking phrase. The function of such a phrase is to help maintain the flow of points. In the above paragraph the phrase also serves another function. It breaks up the text in such a way that it is no longer a list of descriptions. The phrase also has a further important role. It acts as a signpost by sharpening our focus on what has been covered in the paragraph so far (that is, laying down particles) but also signals a slight change in emphasis (that is, it is a continuous process).

There are many words or phrases that can act as linking words such as: *then*, *however*, *furthermore*, *moreover*, *but*, *at the same time*, *in contrast*, and *since*.

In a longer article or account, as well as using such linking and signposting words, you will need to write in paragraphs. Paragraphs play an important role in maintaining the flow of an account. Writing flows from the order of the paragraphs. Paragraphs have a structure. There should be one main point or theme in a paragraph; the remaining sentences develop the topic. *Starting a new paragraph signals to the reader that there is a change of point or theme.*

5 Reviewing and redrafting

At this point you may find it useful to use the review checklist of points (page 20) to comment on our attempt. But we have decided to leave the redrafting of our answer to you! In general we thought our attempt was good and did not need a lot of rewriting. But we should be honest and admit that we had already spent a lot of time previously writing on this topic so it can hardly be called a first attempt!

SAQ ANSWERS AND COMMENTS

SAQ 1 The scientific terms used to replace the phrases or words are italicised.

(a) Interest on this type of bank account is estimated as a *percentage*.

(b) Limestone is a rock formed from the remains of marine animals that have become *fossilized*.

(c) Oil floats on the surface of water because water is *denser* than oil.

SAQ 2 The scientific terms that replace the phrases are italicised.

(a) The length of the *hypotenuse* can be determined using Pythagoras' theorem.

(b) Air is mainly composed of molecules of nitrogen, oxygen and carbon dioxide, the first two being elements and the latter being *a compound*.

(c) *Anaerobic* respiration can occur to a certain extent in muscle cells when they have a lot of sustained work to do.

SAQ 3 This is the same passage broken into short sentences (italicized words have been cut, bold words are new words).

'Finding the density of a rectangular object is very easy but finding the density of an irregular object, such as a broken stone, is difficult. *because* In this case measuring the volume cannot be done directly, so it is found by measuring the volume of water that the object displaces. *which* **This** is done by measuring the difference in the height of water before and after the object has been immersed in a measuring cylinder.'

SAQ 4

(a) As stated it is the hand rather than the acid which is odourless and colourless. 'The odourless and colourless acid burned his hand'. Or 'The acid, which was odourless and colourless, burned his hand'.

(b) The ambiguity centres on the word 'longer' which can refer to either time or length. 'Students south of the border lose their teeth sooner than students from the north.'

(c) Is it the account or the employees which are broken down by age or sex? 'An analysis of the age and sex of senior employees is given below'.

SAQ 5

(a) The colour of the solution changes from the violet of iodine to orange.

(b) The chemical energy of the coal is converted into heat, kinetic and sound energy. (Note the use of the comma to separate items in a list)

(c) Rust is a compound formed when oxygen combines with iron. OR When oxygen combines with iron the compound rust is formed.

SAQ 6

(a) The liquid changes colour from violet to colourless.

(b) The purple vapour rose to the top of the container.

SAQ 7 The correct sentence order is as follows.

'Most metals combine with oxygen; some even do this without being heated. The metal magnesium burns brilliantly in air. You have probably seen this flame in old-fashioned camera flash-bulbs or in firework displays.'

SAQ 8 This answer should be illustrated with a flow diagram.

The energy used initially by the man is chemical energy that is converted into kinetic energy in the arm, heat energy produced by the muscles and gravitational energy of the spade. The kinetic energy of the arm and gravitational energy of the raised spade is converted into kinetic energy of the spade. This in turn is converted into sound energy (of the spade hitting the soil), heat energy (warm spade and soil), strain energy in the distorted soil particles and gravitational energy of the soil lifted out of the hole.

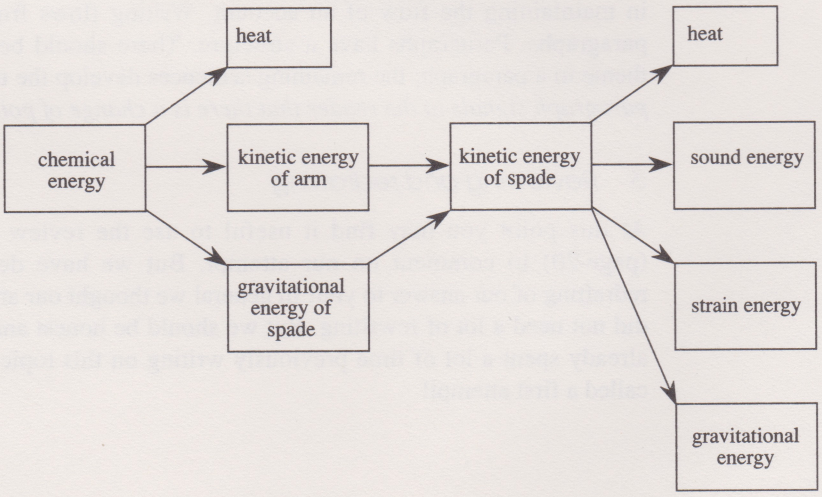


Figure B Flow diagram of energy conversion.
Don't worry if you missed the gravitational energy of the spade.

SAQ 9 Make sure that the calculation is an integral part of the answer and show all your steps in carrying out the calculation.

Since one droplet of water is $1 \times 10^{-7}\,m^3$ the number of molecules it is composed of can be found by dividing the size of the droplet by the size of the molecule as follows.

$10^{-7}m^3 \div 10^{-27}\,m^3 = 10^{[-7-(-27)]} = 10^{20}$

Therefore the number of molecules in the water droplet is 100 000 000 000 000 000 000 or 10^{20}

SAQ 10 Make sure the equation is an integral part of the answer.

The chemical reaction to make lime from limestone is:

$$CaCO_3 = CaO + ?$$

One possible way to balance the equation is to add CO_2 (carbon dioxide) to the right hand side.

The completed equation is:

$$CaCO_3 = CaO + CO_2$$

(This is, in fact, the equation that represents what occurs!)